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ABSTRACT

This report describes a program for increasing students' learning in mathematics and science through the integration of visual art. The targeted population consisted of 30 fourth grade students from a middle class neighborhood located in a large suburban Midwestern city. The problem for the intervention was documented in math and science report card grades from the previous year and in the math scores taken from the standardized ISAT. Pre- and posttest assessment will be administered to measure growth. Analysis of probable cause data revealed three probable causes that contributed to the need to improve learning in mathematics and science. Theses causes stem from the lack of teacher cooperation across curricular subjects, and lack of student motivation, which can be attributed to not identifying individual learning styles, talents, and abilities of the student. These causes consist of: (1) lack of academic value placed on visual art instruction, (2) pressure to achieve and maintain higher standardized test scores in core curriculum areas, and (3) the lack of identification and use of multiple talents and skills. These causes allow students to fall behind. Because the literature review of solutions cited these reasons for lack of integration of visual art into science and mathematics curriculums: misalignment and lack of integration of curriculum, lack of variety in teaching methods, and the failure to use alternative assessment methods, the researcher focused on the solution of integration of these subjects with a variety of teaching methods and the use of alternative assessments. During the intervention of visual art integrated into science and mathematics, data was collected from journal writing and portfolio assessments as well as artwork progress. At the end of the research intervention period, a posttest was administered to measure growth. Final achievement was assessed by the comparison of the pre- and posttest to determine growth of student learning with this intervention. Intervention data indicated a substantial increase was gained in each subject area. Students' knowledge of the concepts taught increased 72% in mathematics, 90% in science, and 68% in art. (Contains 27 references.) (Author)

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IMPROVING STUDENT LEARNING IN MATHEMATICS AND SCIENCE THROUGH THE INTEGRATION OF VISUAL ART

Joyce Hanson

An Action Research Project Submitted to the Graduate Faculty of the

School of Education in Partial Fulfillment of the

Requirements for the Degree of Master of Arts in Teaching and Leadership

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ABSTRACT

This report describes a program for increasing students learning in mathematics and science through the integration of visual art. The targeted population consisted of 30 fourth grade students from a middle class neighborhood located in a large suburban midwestern city. The problem for the intervention was documented in math and science report card grades from the previous year and in the math scores taken from the standardized ISAT. Pre- and posttest assessment will be administered to measure growth.

Analysis of probable cause data revealed three probable causes that contributed to the need to improve learning in mathematics and science. These causes stem from the lack of teacher cooperation across curricular subjects, and lack of student motivation, which can be attributed to not identifying individual learning styles, talents and abilities of the student. These causes consist of: 1) lack of academic value placed on visual art instruction, 2) pressure to achieve and maintain higher standardized test scores in core curriculum areas, and 3) the lack of identification and use of multiple talents and skills. These causes allow students to fall behind.

Because the literature review of solutions cited these reasons for lack of integration of visual art into science and mathematics curriculums: misalignment and lack of integration of curriculum, lack of variety in teaching methods, and the failure to use alternative assessment methods, this researcher focused on the solution of integration of these subjects with a variety of teaching methods and the use of alternative assessments.

During the intervention of visual art integrated into science and mathematics, data was collected from journal writing and portfolio assessments as well as artwork progress. At the end of the research intervention period, a posttest was administered to measure growth. Final achievement was assessed by the comparison of the pre-and posttest to determine growth of student learning with this intervention.

Intervention data indicated a substantial increase was gained in each subject area. Students' knowledge of the concepts taught increased 72% in mathematics, 90% in science and 68% in art.

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Dedicated

to my husband Bruce,

whose insight, exceptional wealth of knowledge

and patience helped guide me through

the past two years

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CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

As the targeted school reviewed test scores and writes their School Improvement Plan, questions arose as to how to improve the teaching process. The focus of concern was on the core subjects of mathematics and science. Site A targeted math as their focus. Site A also planned to integrate the arts into the math curriculum. The targeted fourth grade needed to improve in math according to the standardized Illinois Standards Achievement Tests. Evidence has also been documented by the third grade teachers in the form of report card assessments. This same group of students showed ability in learning kinesthetic and visual concepts in art class. This study looks at the integration of art into the core subject areas of mathematics and science. This allows students to have a hands-on and more visual instruction, thus improving their achievement in these core subjects.

Immediate Problem Context

This study was conducted at an elementary school in a large midwestern city. It is part of a unit school district and located in a middle class neighborhood. This school is referred to as Site A.

Site A was founded 25 years ago. The existing building was renovated and an addition was added in 1997. This addition included a new gym, music room, art room and eight regular classrooms. Remodeling of the original building allowed space for a computer lab. The playground has two separate areas with playground equipment, two blacktopped basketball areas, and a baseball diamond as well as extra field space.

Site A offers grades kindergarten through six. The grade levels are made up of four half-day kindergartens, four first grades, four second grades, three third grades, one third/fourth split class, four fifth grades and four sixth grades. In addition to the regular education classes, Site A also has two exceptional needs classes (EN) classes, one for primary age children and one for intermediate aged children. Beginning in the fall 2000, this site added two bilingual classes, one at the first and the other at the second grade level. In the fall of 2001, a third grade bilingual class was added. Site A currently has an enrollment of 738 students with an average class size of 25.3.

Most students walk to school. This site has students from a neighboring elementary school's attendance area who have chosen the nine-month calendar year instead of attending a year round school. Approximately one-fourth of the students are bused.

The racial-ethnic groups that make up the student population at site A are: 55.7% White, 8.8% Black, 21.4% Hispanic, and 14.1% Asian/Pacific Islander. Of this population, 16.8% come from low-income families. Students whose first language is not English, and are considered limited English proficient, are 17.8% of the student population.

Site A's attendance rate is 96% with a 17% mobility rate. The chronic truancy rate is 1.2%; these are students who miss more that 18 out of the180 school days without a valid excuse.

Special Programs

Site A offers a variety of additional programs to students. These include: the Explorer Program for talented students in grades one through three, Challenge Math program for gifted students grades four through six, outdoor education program for sixth grade students, a collaborative intervention program, a student newspaper, and a conflict management program. Site A also offers extra curricular activities. These include: Battle of the Books, extra-innings homework tutoring program, after school science program, state math league, science fair, art fair, evening music program, field day, and intramural basketball. Site A offers special incentive and recognition to students through honor roll, perfect attendance, and sixth grade recognition.

Staff

Site A has one principal, one full-time secretary, one part-time secretary, and a part-time bilingual liaison and one full-time daytime custodian. It employs 30 full-time classroom teachers. The fine arts staff is made up of three part-time physical education teachers, one full-time music teacher, and one full-time art teacher plus one part-time art teacher. Support staff includes: a social worker, a speech therapist, a teacher of the learning disabled students (LD), a collaborative intervention worker, a teacher of the gifted students, and a librarian. Twenty-five percent of these teachers have completed their masters degree and another 2% are currently working in a masters degree program. Site A's average years of teaching experience is 12.5. Of the 47 employees at site A, nine are male. The racial and ethnic makeup of the staff is 2.1% Black, 4.2% Hispanic, and 2.1% Asian, with the remaining 91.5% majority White.

Schedule

Students receive 45 minutes of art instruction per week in grades one through six. Kindergarten students receive 30 minutes of art instruction per week. The daily schedule for the full-time art teacher is five 45 minute periods each day of the week. A part-time art teacher covers the four 30 minute kindergartens and one 45 minute first grade class

Special Equipment and Budget for Art

The art room has two computers with Internet access, a television, a videocassette recorder, and a device that allows the image on the computer screen to be projected on the TV screen for larger viewing. It also has a slide projector, a compact disk/cassette player, and a kiln. Books, art prints, slides and computer software are part of the classroom supplies. The district provides a budget of $1.75 per student making Site A's art budget about $1292. The Parent Teacher Organization (PTO) at site A also contributes to funding for art supplies, but this amount varies from year to year. Art teachers can order from the district warehouse or order from outside vendors.

Art Curriculum

The current art curriculum was written by five art teachers within the district and was adopted by the school district in May 1999. This document is based on the goals, outcomes, and experiences outlined by the state as well as the district. Teacher rationale for this curriculum includes being user friendly and exhibiting a basic outline for continuity through the district. Student rationale includes understanding of basic skills and techniques, the creative expression of ideas, a basis for assessment, and providing quality experiences that lead to art awareness and art appreciation. The curriculum addresses the elements of art and the principles of design. It lists vocabulary and describes media to be experienced. Lists of art prints, artists

and their styles are also outlined. The curriculum relates information about different cultures and art history.

The Surrounding Community

Site A is located in the northern section of a large unit district. This district has a history for being on the educational forefront. It abandoned segregated schools in 1871, and in the 1920's it was one of the first districts to offer kindergarten. It pioneered a junior school high model in 1932. The district currently offers alternative schools. It recently completed the largest school construction in the state's history.

This district employs one superintendent and three area superintendents. This district provides education to children in preschool through 12th grade. Currently this district has 49 schools; 38 elementary schools, seven middle schools, and four high schools. Including superintendents and executive staff, teachers, assistants, lunch supervisors, secretarial/clerical staff, custodial and maintenance, technical support, food service, and administrators, this district employs over of 4,300 people.

This district serves portions of 11 different suburban cities. It covers 90 square miles and extends through three counties. The city in which site A is located was incorporated in 1854 and covers 24 square mi'es across two counties. It operates under a council manager form of government, with a mayor and six city council members. This city's location has contributed to its growth. The state planning commission projects the population to increase to 100,000 by the year 2010. This city's historical district is one of the oldest and largest in the state. This community has many parks and recreation activities that include an aquatic center, city run camps, fitness programs, a cultural center, a public museum, soccer, softball, tennis and teen and youth programs.

Site A reflects a diverse neighborhood. Almost 25% are of Hispanic heritage; less than 12% Black and 16% are of Asian background. The community contains single-family homes as well as apartment buildings, and subsidized housing. The median household income is $27,000. Forty-three percent of the households have children. Many parents volunteer to help with fundraisers and tutoring, as well as being leaders of Girl Scout and Boy Scout groups.

The above statistical information came from site A's school report card, site A's website, the city website, and the district art curriculum guide.

National Context of the Problem

School district principals and administrators seek evidence that the arts will help meet state and district goals for student learning to justify their existence, funding and allotment for classroom space. Currently, art teachers in this district have to "fight" to get or keep a room for art by justifying the need at district board meetings. Each spring as classroom planning is done for the next school year, art rooms are in danger of being used to house new bilingual and regular education classrooms as the district grows. Yet research shows that the arts are valuable to the basic education of student learning. "I take with me my beliefs that both art and writing are means of expression and when practiced together, they have a profound impact on how children find their voice" (Ernst, 1998, p.32). The collaboration of the art teacher with the classroom teacher in an effort to revise ideas and enhance student learning could be an answer to learning processing problems. Each student learns differently. It is known some students are auditory learners, some are hands on, kinesthetic learners and some are visual learners. Many need a combination of these styles.

Visual art is a link to other subjects as well as a part of everyday life. In art the concepts of line, shape, balance, size relationships, measuring, estimation and organization of design are taught. These concepts are directly related to math objectives.

> People of the Eastern and Western worlds have used mathematical ideas to create patterns in woven fabrics; ornamentation for religious objects and places of worship; and adornment of the walls, floors, and ceilings of the homes of nobles. A significant amount of mathematics, including the principals of symmetrical relationships, is implicit in such designs (Natsoulas, 2000, p.364).

The use of art elements and principles to visually explain an abstract mathematical concept, then allowing the student to create the design, gives the student a greater chance for understanding.

Art can entice students to read and help access their knowledge of what they read, as well as help them remember information. The illustrations in a book give the reader clues to the text as well as incentive to continue reading. Art appreciation shows students how to "read" an illustration, painting or print. When students transfer this technique to reading and take a close look at what is happening and gathers details, it gives them a preview of what is going to be read. When students use their imagination to picture in their minds what the story tells, then draw their interpretation, artwork can be used as a form of assessment for comprehension. "Reading the words can create an image in the mind. This is an important reading strategy and can connect art to the curriculum" (DaSilva, 2000, p. 40). Drawing an image and thinking through all the details leaves a lasting memory for future reference, like the taking of notes, only more vividly.

As pointed out by Laurene Ring, a gifted and talented resource teacher, who taught an art appreciation unit, " The objectives were for her students to develop: analytical and interpretive skills; persuasive writing skills; literacy in the language of art; listening and oral communication skills; and reasoning skills" (Ring, 2000, p.36). This allows teachers to design lessons that provide a setting that facilitates higher order thinking skills. The combination of writing and the production of art is both challenging and of high interest to students. Getting and keeping their interest in learning is another key to high success.

Shady Brook Elementary School in Bedford, Texas initiated an art education program developed by the Getty Institute for the Arts. This program moved art education from the academic edge to the core curriculum. Reading scores, measured by the Texas Assessment of Academic Skills (TAAS) improved 12.3%, in the past five years, writing scores improved 14%, and math scores improved 61%. In 1997, all sixth-graders demonstrated reading mastery. "Beyond the TAAS scores, anecdotal and empirical evidence shows how comprehensive arts education is enhancing students' ability to understand concepts and express themselves articulately" (Chapman, 1998, p.58).

"The language of art has become the next literacy - or the fourth R" (Ohler, 2000, p.16). To be successful in today's world, students need to be competent in the digital world. Students need to be fluent in the aesthetic make up of how to put visuals together to show what they are trying to communicate, not just competent in the use of technology. The ability to organize ideas in terms of visual elements on the computer needs to be taught. The knowledge of how to use the computer versus how to create a document that is visually stimulating and useful are two different issues.

Art is a large part of social studies and history units because it is a reflection of culture and history. " There has never been a culture or society that did not create some kind of art. Great cultures have flourished without a written language, but never without art" (West, 2000, p.176). Historians depend on the art of past cultures for key information. "The critical study of visual art gives the student a sensitivity to and understanding of beliefs and ideas that are the cultural foundation of all humanity" (West, 2000, p.176).

Art also has links to science. Color theory, illusions, shadow and light, size relationships and distance are some areas that crossover in both art and science curriculums. Young scientists also use drawing to document experiments and inventions.

All across the curriculum art is a necessary element for understanding. With the above information in mind, art should be given equal consideration in instruction time, funding and classroom space. It is valuable in its own right, instilling the development of creative and well-rounded students. "The impact on teaching and learning has been profound, enabling us to view our entire core curriculum as a meaningful whole rather than as isolated subjects" (Chapman, 1998, p.59). Art also empowers students with skills that are transferable to other subjects and is an important part of living in the modern innovative world. With schools and districts looking to improve students' test scores, they must not overlook the impact visual art has on students' learning. Using art as a tool to increase students' learning seems very practical.

CHAPTER 2

PROBLEM DOCUMENTATION

Problem Evidence

Problem evidence showing the need to increase student learning in mathematics and science was gathered from report card assessments, and from the previous year's Illinois Standards Achievement Tests (ISAT) mathematics scores.

Report Card Grades

Figure 1 shows report card documents at site A, where 35% of the students in the targeted group had received an A in mathematics the previous school year, 26% received a B, 32% received a C, and 7% received a D. Of these same students, 32% received an A in science, 23% received a B and 45% received a C. Thus, 64% attained mastery of mathematics concepts, which are students receiving a letter grade of B or above, while 39% of the group exhibited only partial mastery of mathematics concepts or received a C or a D. This figure also shows mastery of science concepts to be at 55% and partial mastery of skills to be at 45%. These high percentages of partial mastery of skills from the previous grade reveal a need for improvement.

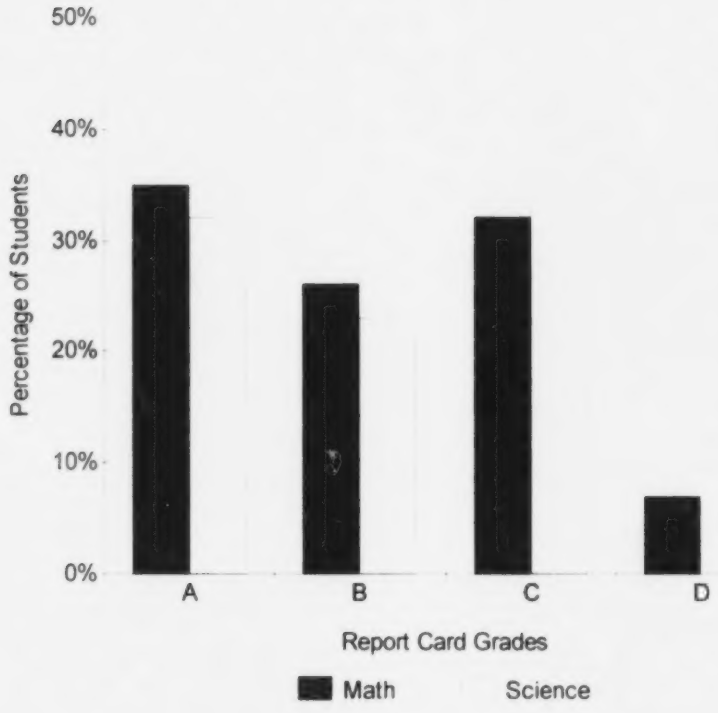

Figure 1. Mathematics and science report card grades from previous year

Art grades at site A are given with ratings of one to three instead of letter grades according to district policy. A one indicates the student exceeds set standards, a two indicates the student meets set standards, and a three indicates that the student did not meet the district set standards. The chart in figure 2 shows student strength in the subject of visual art. The first column represents the 54% of the students that exceed the district expectations. The second column represents the number of student that meet district expectations to be 39%. This leaves the third column, which represents a small 7% of the students not meeting district expectations.

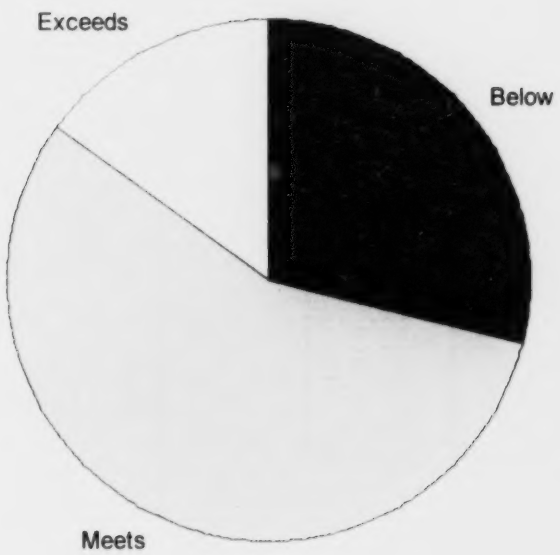

Figure 3. Percentage of students meeting ISAT standards for mathematics.

Teacher-Researcher Created Pretest Results

The teacher-researcher created a cross-curricular test based on the fourth grade art, science and mathematics curricula because of site A's need to improve in mathematics and science. Of the 15 questions, four were mathematics questions, four were science and seven were art questions. The test consisted of 15 possible correct responses. The questions asked for student response in the form of written words or drawn representations to show examples of student knowledge. For this test, the mastery level was 85% and above, the partial mastery was 70 to 84%, and non-mastery was below 70%. Figure 4 shows the percent of correct pretest questions. The highest score was 5 out of 15, or a score of 33%, which ranks at non-mastery level. The average score was 1.5 questions. Over 32% of the students left the test blank except for their name and the date.

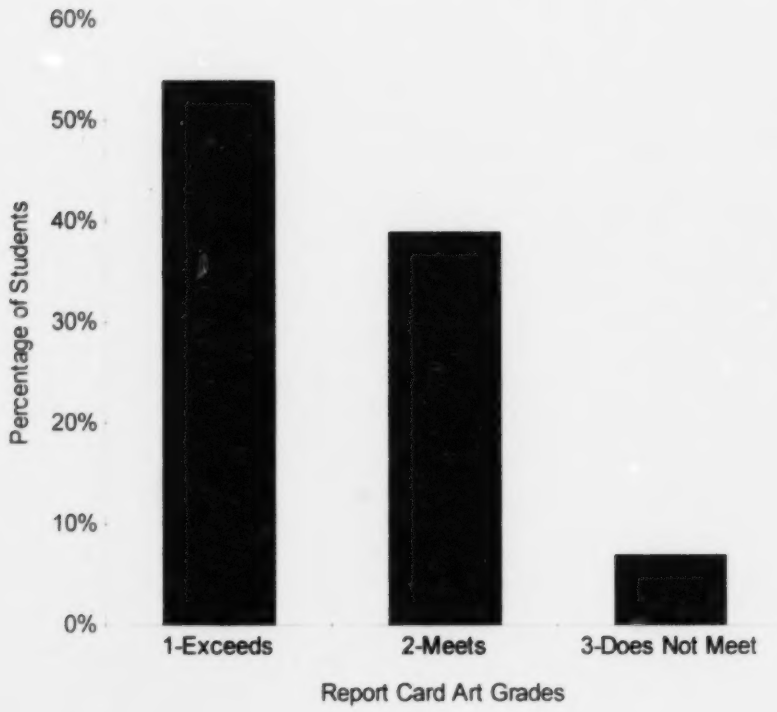

Figure 2. Art report card grades from previous year

ISAT Scores

According to the Illinois Standards Achievement Tests test results for mathematics, site A's targeted group at the end of third grade showed that 15% of the students exceeded the state standards, while 56% met the standards and 29% were below. Of the 29% below the standards 5% were on academic warning. Figure 3 illustrates these proportions. This 29% of students not meeting the state standards for mathematics is a higher percentage than both the district average of 24%, and the state average of 26%. The ISAT description of the below standards level is students who have gaps in learning and apply knowledge in limited or ineffective ways.

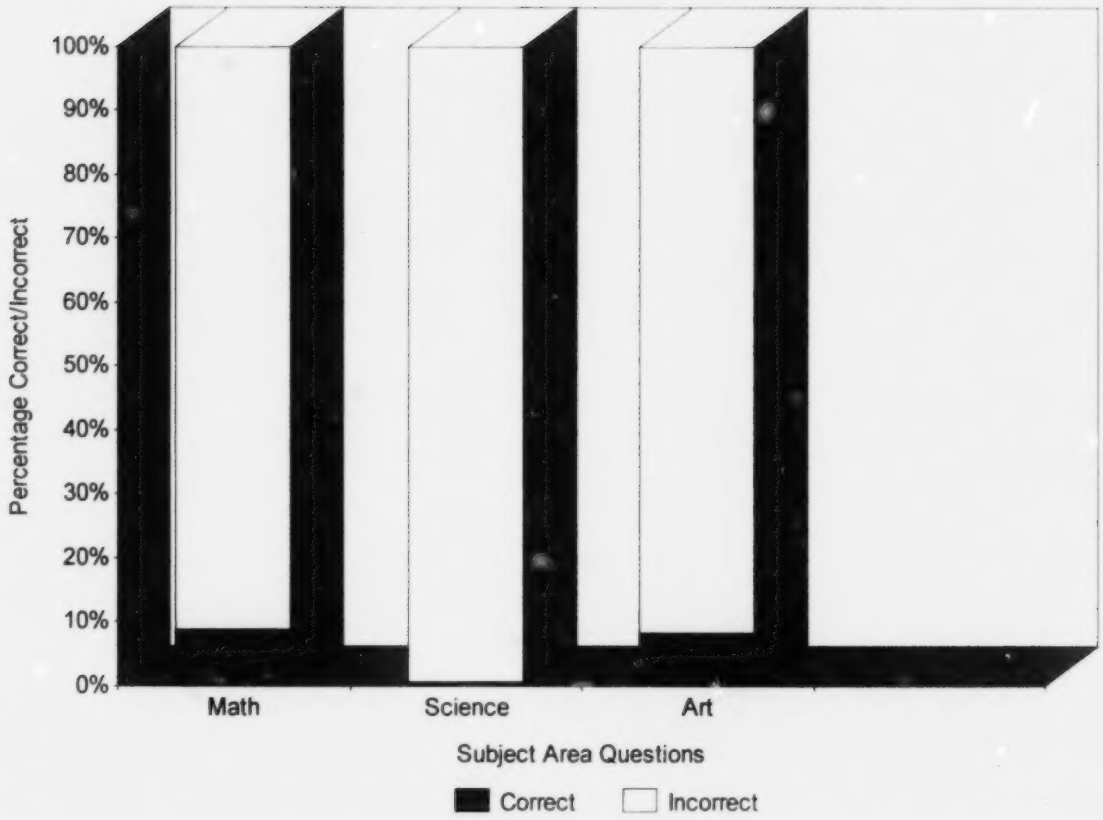

Figure 4. Percentage of correct pretest questions.

In summary, the charts above provide problem evidence. The previous year's report card grades rank a large 39% of the targeted group at a partial mastery level of skills in mathematics and science, while the ISAT scores present an even more dramatic drop in mastery of skills in mathematics. They show 56% at partial mastery and 29% at below standard in mastery of concepts. On the cross-curricular pretest, these fourth grade students scored very low on concepts in the fourth grade curriculum in mathematics, science and art. Almost one-third of the students did not even attempt to answer any questions. The highest score was 5 correct out of 15 possible correct answers. This collected evidence shows a need for intervention.

Probable Causes

The literature notes three probable causes that contribute to the need to improve learning in mathematics and science. They stem from lack of teacher cooperation and lack of integration across curricular subjects, and lack of student motivation, which can be attributed to not identifying student learning styles, talents and abilities. These causes consist of: 1) lack of academic value placed on visual art instruction, 2) pressure to achieve and maintain higher standardized test scores in core curriculum areas, and 3) the lack of identification of multiple talents and skills, which cause students to fall behind.

Lack of Academic Value

The first cause, lack of academic value placed on visual art instruction, may result from not fully understanding the subject and its potential for student learning. As students exit kindergarten they are given the ABC Reading Readiness Test which includes drawing the human figure. This is done to assess the student's ability in appropriately identifying parts and placement. This shows direct correlation to maturity and reading readiness. However, this will be the last time the use of drawing skills is used in a standardized test to assess learning ability. Since students learn in different ways, teaching styles need to be considered in ranges of difficulty to challenge students and varied in methods of delivering the information to keep interest levels high.

> Anyone who spends even a short period of time in a classroom sees that students differ not only in physical appearance but also in how they learn, what their interests are, the prior experiences they have had, and their cognitive strengths and weaknesses. A "one size fits all" model of instruction cannot possibly reach all students in the classroom, according to Sizer. (as cited in Skowron, 2001, p.5)

Bruce Campbell contrasts his teaching style using diverse activities with the traditional teaching strategies: "I began to find my satisfaction in their enthusiasm for learning and independence, rather than in their test scores and ability to sit quietly" (Campbell, 1990, p.254). In contrast to traditional teaching, a good art program encourages interaction, and necessitates manipulation of materials and media through trial and error to achieve understanding and to communicate ideas. This allows for unlimited variation of a correct interpretation and yet have no two pieces of art visually the same.

Some view art as an unnecessary frill. "How can we teach art when so many children are struggling to read, write and figure? (Gaines,1999, p.1). The processes of observing, discovery and creation allow students to interact and absorb information that becomes part of them, a framework they can use in their everyday life. "Children also need access to the power of individual expression that the arts afford. Some students may not find academic success without it" (Tilney, 2001). Gifted classrooms are known for integrating across the curriculum. Why should only a portion of students have this option in the learning process? Teaching and expecting only lower level thinking shuts out creativity. "Teaching for creative thinking involves helping students create, explore, discover, imagine and suppose. Students need to think flexibly and view things not only as they are, but as they might be or become" (Sternberg, 1998, p.1).

Pressure to Maintain Higher Standardized Test Scores

President Bush's Education Plan, "No Child Left Behind," is an attempt to patch the achievement gap. This "gap" is measured by standardized tests that assess student learning with multiple-choice questions. "The everyday problems of life and work cannot be solved like a multiple choice test" (Gaines, 1999, p.4). This narrow form of assessment cannot accurately

indicate knowledge learned. This usually means lessons and assessments cater to only students who excel in reading, writing and math, the areas that are assessed on the achievement test. Other students without a strong aptitude in those three areas are left behind. Jason Ohler points this out in his quest to have art literacy taken more seriously, "We need more art teachers working across the curriculum with content-area teachers" (Ohler, 2000, p.19).

The national ranking in test scores takes precedence over students' needs as teachers are considered only as successful as their last set of standardized test scores. Newspapers make front page announcements stating, "Despite an aggressive effort to improve academic achievement across the state, Illinois' school pupils slipped last school year in reading and writing and barely improved in math, according to test scores ", (Chicago Tribune, 2001, p.1).

> Some argue that schools are not in the business of developing such skills at the virtuoso level, that basic motor skills should suffice. O.K. but I wonder why these same people relentlessly press for (1) higher performance standards in curricular areas whose skill component is being displaced by computer technology, and (2) the simultaneous reduction of programs that move students from basic to advanced levels in arts areas that are so central to the human spirit (Sylwester,1998, p.33).

Memorization of spelling lists, formulas, and dates are often drilled into students as preparation for standardized testing. The practice of repetitious skill lessons often turn students off to learning.

> The road is littered with insecure students who are bored, humiliated, fearful, competitive, frustrated, terribly sad, and occasionally violent. The school atmosphere is so stressful that students vie with each other for the best grades and the teacher's approval, or display negative behaviors. Wounded egos abound, because students are made

> to feel that they are never quite skilled enough – even the gifted student is embarrassed to make a mistake. (Azemove, 2001, p.1)

Unless information is relevant to the student, it will go into short-term memory and be lost before taking the standardized test. Sylwester (1998) believes that emotion drives attention and attention drives learning. What is important or interesting is what will be retained in memory. Lost are things considered not important.

The end result of placing too much emphasis on standardized test scores is more problems. Due to high-stakes standardized testing, there has been a dramatic rise in student dropout rates, especially among Black and Hispanic students. "The negative effects of high stakes tests don't end there. Under pressure to raise test scores, some school systems have trimmed--or eliminated – recess, field trips, the arts and music, science and social studies (when not on the test) and physical education" (Chase, 2001, p.5). Schools are tailoring the curricula to meet one goal – higher test scores, neglecting student need for variety, enrichment and cross-curricular understanding. Decisions on how and what to teach are not based on increasing student knowledge, not for competition for higher numbers on standardized test scores.

Lack of Identification of Talents and Skills

With the focus on test scores, individual student learning skills, abilities and talents are overlooked and many times totally disregarded as useful. Talented students often fail in the regimented test cycle when that is the only method of assessment. One student was described as coming to school with the wrong abilities. He could play almost any tune on the piano, with little effort and composed several pieces for a talent show. He accompanied the fifth grade concert when the school's pianist took ill. This boy failed the tenth grade and dropped out of school (Weber, 1992). The traditional practice, memorize and learn theory, did not work for

him and does not work for many. This student's talents and abilities were dismissed, and the narrow view of intelligence his school held allowed him to fall through the cracks. This musically talented student needed a teacher who would take the time to adapt concepts across the curriculum to tap his method of learning, thus encouraging him to be a successful learner.

Students with valuable knowledge and skills are often discouraged. "Young kids come to school with the ability to draw, sing and dance, and perform fabulous dramatics. But as they soon learn these things don't matter" (Gaines, 1999, p.1). Students need to receive and process information in many forms, not just through direct teaching of one subject separated from other subjects. More appropriately, the connections among curricula help students see the whole picture. By teachers making these connections and inviting students' talents to be a part of the learning experience, students open up new areas that would otherwise never be used. With higher test scores as the goal, the answer to higher achievement by all students may be to encourage them to use their varying intelligences to understand the curriculum as a whole.

Art can also provide a focus; without it some students fail to find a goal. Nan Elasser, the founder of Working Classroom, describes one student ready to drop out of school. "Here is a girl with phenomenal talent, but she didn't have a clue what to do." (Zibart, 1998, p.5). Discounting the methods of learning and natural talents students have does them a great disservice in learning and self-worth. Without formal art instruction this student did not work up to her potential. After given the opportunity and direction this student thrived and achieved success. Many students may be beginning to grasp the material or be on the verge of understanding a concept but need the freedom to express their knowledge and think through processes in their own way. Then they can take personal ownership in the learning of new material and pride in their own talents.

> Elementary school children who err on mathematics problems sometimes know more than they say. These children explain their flawed math reasoning while using gestures that betray budding insights. They just as well say to their teachers: "Read my hands! I'm on the verge of some serious learning here!" (Bower, 2001, p.172)

Viewing the problem differently, using different strategies or being able to manipulate materials to make the abstract concept more concrete gives the students options on how they learn. Students may be using a trial and error method or visually drawing images, in order to map out the concept, or remind themselves of how they came to a conclusion, or as a basic note taking technique. Students who are struggling with concepts only to have the process interrupted by anxiety may never overcome the block without the use of alternative techniques.

> People's intrusive worries about math temporarily disrupt mental processes needed for doing arithmetic and drag down math competence. Math anxiety exerts this effect by making it difficult to hold new information in mind while simultaneously manipulating it. Psychologists regard this capacity, known as working memory, as crucial for dealing with numbers. (Bower, 2001, p. 405)

The negative effect on students who are continuously discouraged impacts their future learning. Students who have visual art integrated into their curriculum have the opportunity to grasp concepts visually and/or kinesthetically with traditional instruction, allowing more chances for success.

Throughout history, society has been impacted with people who think differently, have solved problems or made discoveries in new and different ways. M.C. Escher used his art

prints to illustrate and explain hyperbolic geometry. "Besides intriguing professional mathematicians, Escher's Circle Limit prints and their repeating patterns prove to be useful vehicles for becoming comfortable with, and teaching, hyperbolic geometry, even to mathematicians, hyperbolic geometry is not that familiar" (Peterson, 2000, p. 409). Louis Comfort Tiffany and Thomas Edison complimented each other in lighting up the early part of the 19th century. Steve Martin's play, Picasso at the Lapin Agile, compares the similarities in knowledge and views of Picasso and Einstein, masters of art and science. Martin's play dramatically shows how the power of art can change lives.

Educators must understand the difference among students, and the need to reach each one in our teaching. "In our school district, principals and other building administrators want evidence that the arts will help them meet district goal for student learning," (Stankiewicz, 1997, p.8). The impact visual art can have on student learning can mean learning a broader perspective of a concept of knowledge and learning to some, and to other students it means the difference between staying in school or dropping out. A narrow view on the value of art versus core curriculum subjects means cutting out options for many students. Disregarding skills, talents, and abilities and refusing to use alternative assessment methods, hinders the learning of students and unfairly labels their gifts and abilities outside core subject areas.

In conclusion, the above-cited evidence has shown that the integration of visual art across the curriculum enhances learning for all students. This method of teaching and learning exhibits a wider view allowing the success of more and a deeper understanding of concepts cross the curriculum. When understood and creatively taught, visual art can be a dynamic tool for enhancing the entire curriculum. Visual art's academic value should not even be questioned. The end result of infusing art into the core subjects will ultimately increase test

scores as students gain a broader view of subjects as a whole. The identification of multiple talents and skills will be seen as an asset to student learning instead of a label to justify their learning limitations. Playwright George Bernard Shaw suggested that one use a mirror to see one's face and the arts to see one's soul. Looking deeper is exactly what is needed in the whole teaching and learning process by both students and teachers and well as parents and administrators.

CHAPTER 3

THE SOLUTION STRATEGY

Literature Review

The lack of integration of visual art into mathematics and science curriculums can be attributed to three factors. These factors consist of: misalignment and lack of integration of curriculum, lack of variety in teaching methods, and the failure to use alternative assessment methods. Each factor is equally important and the solutions to correct the problem are to align the curriculums, use a variety of teaching methods, and use alternative assessment methods.

Curriculum Alignment

Chapter two noted the first probable cause as lack of academic value placed on art as a subject. "Art is more than a well-placed painting on the wall, more than a strategically lit Roman sculpture, art is a vital part of our everyday existence" (Stevens, 2002, p.1). Being well versed in art history concepts, and skills, allows for connections in everyday life. Art influences both everyday communication and learning.

All curricular areas need to be aligned with each other. Kathleen Fitzpatrick in Indicators of Schools of Quality discusses the importance for interdisciplinary goals to reinforce connections across the curriculums, thus making the content more meaningful to student learning in each content area (Fitzpatrick, 1998, p.12). The reinforcement of concepts kinesthetically and visually through art, as well as the regular classroom instruction in art, encompass the variety of learning methods and skills. "Teachers who value the arts often

integrate them with other subjects and teach through the 'lens' of the arts" (Tinley, 2001, p.3). The carry-over of skills and concepts throughout the curriculums strengthens students' abilities to search for information and solve problems in any situation. They can depend on their own thinking and questioning skills to find answers instead of feeling as if the teacher holds the sum of knowledge.

> For one thing, students learn to look at art in an analytical rather than emotional way and are able to transfer this skill to other disciplines. They quickly sense the benefits of being able to mentally unwrap and interpret a work of art. This sense of accomplishment spurs them to apply logical thinking elsewhere—to a story or book, a science experiment, a long division problem." (Chapman, 1998, p.58)

Variety of Teaching Methods

Chapter two's investigation of probable causes also points to the lack of identification of student talents and skills. Visual communication is a talent and a skill, but not limited to only those with natural ability. Just as students learn to communicate by learning to write letters and decoding sounds and associating meaning, art is another option for expression of ideas. Understanding art unlocks new ways of thinking and organizing information, thus internalizing the learning of concepts.

Brainstorming, group work investigation, questioning, conducting experiments, observing, comparing and contrasting and the creation of their ideas in two- and three-dimensional forms are a few ways to motivate interest and help students adopt powerful learning strategies. Positive reinforcement of new and innovative ideas and opinions can repattern thinking to more open-minded and endless possibilities. D.N. Perkins describes this repatterning as mindware, or the tools for the mind. He uses the term mindware as "...anything a person can learn -- a

strategy, an attitude, a habit -- that extends the person's general powers to think critically and creatively" (Perkins, 2001, p.3). Since each student is unique, students learn in a variety of styles. All students have strengths and interests in favorite subject areas. Using these strengths and interests inserted in other areas of the curriculum could be the answer to increased motivation for learning. When varied styles of teaching are intermingled across curriculums, it makes the information more interesting for all students.

> It [the success] demonstrates quantitatively the remarkable value of integrating arts experiences into the curriculum. It means, too, that teachers who use the arts and cultural programming in the classroom can bring enthusiasm to the core curricula. As one teacher said, "The children really started to see connections... and it's been fun seeing them respond to that.... Once they get started, they find similarities all over the place." (Chapman, 2001, p.59)

Alternative Assessment Methods

The third probable cause contributing to the problem, involves the pressure to achieve and maintain higher standardized test scores in core curriculum areas. Districts are trying to focus on the basics to achieve higher test scores, using a standardized score to measure the knowledge to each student. The exclusion of other forms of assessment narrows the overall picture of what the student actually knows and has learned.

Alternative assessment methods are also an important element to the solution. Student self-assessment allows students to set value on what they are learning and creating. In the writing of journals students, self-reflect, rethink work, and actually think about the thinking process. (metacognition). These are the structures that enable learning. Rubrics allow students to have more control over the assessment process because they know how much of an assignment and

to what detail and effort they have completed it. A portfolio would be a way for students to collect a body of work of related ideas, thus making connections in learning. Rubrics, portfolios, and journals are some of the assessment tools that that can provide a basis for both teacher and student to reflect on what was accomplished. So whether student achievement or intelligence is considered one must remember, "If we want to measure intelligence, we can and should measure it broadly rather than in narrow ways that have failed to give a true picture of human capacity" (Sternberg, 1998, p.3).

In conclusion linking visual art to major state and district goals in mathematics and science strengthens student learning, helps to meet student needs and aligns with the priorities of the school system. The integration of visual art into the core curriculum areas adds value by providing necessary alternatives to teaching and assessing students' true abilities.
When teachers create partnerships with art teachers to integrate the arts into the curriculum, they can better achieve the district goal of higher test scores. The alignment of curriculums, the variety of teaching methods and alternative assessments can help students make connections, which in turn will increase student learning in mathematics and science.

Project Objectives and Processes

As a result of integrating visual art with mathematics and science concepts during the period September 2001 through December 2001, the targeted fourth grade at site A will increase their knowledge base in mathematics, science and art, as measured by posttest achievement.

In order to accomplish the objective the following processes are necessary:

1. The teacher-researcher will align district mathematics and science objectives with the art curriculum.

2. The teacher-researcher will collect, order and organize art materials for integrated units.
3. The teacher-researcher will create a series of visual art learning activities and projects that include varied methods of teaching as well as varied experiences such as conducting scientific experiments, observations and investigations, as well as exploring mathematical relationships, physical models and concepts.

The following action plan was designed to improve student learning in mathematics and science through the integration of visual art using integrated lesson plans, varied methods of teaching, and visual art experiences. Students will keep journals documenting information, insights, and visual/kinesthetic art experiences. The purpose of the journals is to facilitate learning by acknowledging what students already know, posing questions on what they want to learn and concluding with what they discovered. Students will also compile a portfolio of work. This portfolio will show students' designs, thoughts, revisions, experiments and processes through final works of art. Assessment tools will include a portfolio rubric to be used by both teacher and student. The teacher-researcher will document a lesson planning log. This log will show the time spent preparing and organizing materials and working with the cooperating classroom teachers.

Project Action Plan

The following table describes the project action plan. It details the intervention used each week and outlines what the teacher-researcher will do to prepare and implement the interventions. The materials are listed at the appropriate weeks when they will be used. The implementation time is one art period 45 minutes in length per week. The targeted group is 30 fourth grade students at site A.

Table 1. Project Action Plan

PROJECT OBJECTIVE	INTERVENTION	TARGETED GROUP BEHAVIOR	TEACHER RESEARCHER BEHAVIOR	MATERIALS	TIME: FREQUENCY AND DURATION
To increase student learning in math and science through the integration of visual art	Develop materials that foster learning through integration of subjects	None	Researcher aligns math, science & art objectives & concepts	Math, science & art curriculums	Late summer before school begins
To increase student learning in math and science through the integration of visual art	Develop materials that foster learning through integration of subjects	None	Researcher reviews and collects/order materials to integrate math & science with visual art	Collected math, science & art supplementary materials	During teacher work days prior to the beginning of the school year
To increase Student learning in math and science through the integration of visual art	Develop Materials that foster learning through integration of subjects	None	Researcher organizes units and individual lesson plans	Develop materials for integration of subjects	During teacher work days prior to the beginning of the school year and adjusting revising as needed
To increase student learning in math and science through the integration of visual art	Set up portfolio & journal systems to foster student learning	Fourth grade students create portfolios and begin journaling	Researcher directs students through process	Portfolios, journals	Week 1 of research project (One 45 min. period)

PROJECT OBJECTIVE	INTERVENTION	TARGETED GROUP BEHAVIOR	TEACHER RESEARCHER BEHAVIOR	MATERIALS	TIME: FREQUENCY AND DURATION
To increase student learning in math and science through the integration of visual art	Administer pretest to assess prior know-ledge of math, art & science concepts	Fourth grade students take pretest	Researcher administers and corrects pretest	Math, art & science concepts pretest	Week 2 of research project (20 min. of 45 min. period)
To increase student learning in math and science through the integration of visual art	Introduce concepts 2-D and 3-D shape/form	Fourth grade students journal concepts through writing and drawing	Researcher explains concepts w/visuals and models journaling	Examples of shapes and forms, drawings illustrating concepts of 2-D/3-D Journal Portfolio	Week 2 of research project (25 min.)
To increase student learning in math and science through the integration of visual art	View prints of musical instruments describe, name, break down into parts compare to 2 and 3-D shape form	Fourth grade students create a sketch designing their own instrument	Researcher guides discussion & models drafting techniques	prints ebony pencils drawing paper Journal Portfolio	Week 3 of research project (one 45 min. class period)
To increase student learning in math and science through the integration of visual art	Demonstrate how to turn 2-D shapes into 3-D form	Fourth grade students create an armature	Researcher demonstrates process monitors students at work	oak tag cardboard rolls small boxes newspaper masking tape scissors small tin cans Journal Portfolio	Weeks 4 and5 of research project (two 45 min. class periods)

PROJECT OBJECTIVE	INTERVENTION	TARGETED GROUP BEHAVIOR	TEACHER RESEARCHER BEHAVIOR	MATERIALS	TIME: FREQUENCY AND DURATION
To increase student learning in math and science through the integration of visual art	Demonstrate how to sculpt over armature in paper mache`	Fourth grade students create sculptures in paper mache`	Researcher demonstrates possibilities, monitors student work	paper mache` paste newsprint paper towels Journal Portfolio	Weeks 6 and 7 of research project (two 45 min. class periods)
To increase student learning in math and science through the integration of visual art	Introduce color unit, compare/ contrast colors of light colors of pigment	Fourth grade work in rotating groups and perform color experiments at different work stations	Researcher will pose questions for each station	Materials for experiments set up at different stations Journal	Week 8 of research project (one 45 min. class period)
To increase student learning in math and science through the integration of visual art	Discuss color combinations	Fourth grade students will choose a set of colors.	Researcher will review last week's experiments and teach color combinations	Handouts on color, tempra paint, brushes Journal Portfolio	Week 9 of research project (one 45 min. class period)
To increase student learning in math and science through the integration of visual art	Introduce: Cubism Picasso geometric similar congruent balance symmetry asymmetry and radial balance	Fourth grade students will compare/ contrast cubist paintings and geometric shapes create cut paper designs to add to the body & arm of musical instrument	Researcher facilitates unit	Art prints construction paper, scissors glue Journal Portfolio	Weeks 10 and 11 of research project (two 45 min. class periods)

PROJECT OBJECTIVE	INTERVENTION	TARGETED GROUP BEHAVIOR	TEACHER RESEARCHER BEHAVIOR	MATERIALS	TIME: FREQUENCY AND DURATION
To increase student learning in math and science through the integration of visual art	Introduce Impressionism light shadow color line variation geometry line terms	Students will mix colors & add line designs to the shape designs on their instruments	Researcher facilitates unit	Art prints paint palettes brushes Portfolio Journal	Weeks 12 &13 of research project (two 45 min. class periods)
To increase learning in math and science through the integration of visual art	Teach sound pitch volume vibration	Students will create a sound box with 4 variations in pitch, high to low	Researcher motivates students	metal cans rubber bands masking tape Journal Portfolio	Week 14 of research project (one 45 min. class period)
To increase student learning in math and science through the integration of visual art	Demonstrate how to install sound box and coat with varnish	Fourth grade students will finish their instruments	Researcher gives demonstration	brads varnish brushes Journal Portfolio	Week 15 of research project (one 45 min. class period)
To increase student learning in math and science through the integration of visual art	Administer posttest pass out music for songs	Fourth grade students take posttest Play instruments	Researcher administers post-test Enjoy students music	Post-test Written music Journal Portfolio	Week 16 of research project (one 45 min. class period)
To increase student learning in math and science through the integration of visual art	None	None	Researcher corrects posttest, compares to pretest, documents evidence	pretest posttest	Week 17

Methods of Assessment

In order to determine the effects the integration of visual art has on student learning in mathematics, science and art, a pretest and posttest will be administered. The pretest and posttest are the same written test. Students are asked open-ended questions on the subject areas of mathematics, science and art. The questions are directly correlated with concepts taken from the district curriculum in these subject areas. Students are asked to write and or draw their interpretation of their ideas to complete the answers.

Student portfolios and journals will also give details on student learning progress. In their journals students will be asked to write about their work, documenting what was learned, difficulties and accomplishments and opinions. Students will also compile a portfolio of items showing the processes through the final work. An assessment critique will also be completed by the student as the project progresses and is finished. The variety of assessments will give students a wider base to express their thoughts and creative ideas as well as help students assess themselves on their accomplishments. This also gives the teacher-researcher and parents insight into the thought processes of the student in the completion of the artwork. This greater understanding makes it easier to assess the students on a variety of levels.

From the literature information was drawn on which to base this research on integrating subject area curriculums. The literature pointed to curriculum alignment to reinforce connections across the curriculums. It also pointed out how art strengthens students' abilities to search for information and solve problems and to apply logical thinking elsewhere.

The literature also documented opinions on the power of varied teaching methods. For students to think in more innovative and open minded ways they need the tools and methods to learn. These varied teaching strategies can extend students' attitudes and habits to motivate

creative and critical thinking. Alternative assessment was also shown to be an important solution. The use of alternative assessment tools gives a broader picture of what the student knows and has achieved in learning. In the literature, other successful programs based on this theory of integration of art into the curriculum were found such as Robert Chapman's Shady Brook Elementary as well as many others based on the Getty Institute's theory of integration of visual art into the core curricular areas. The actions of this plan will try to improve student learning in mathematics and science through the integration of visual art.

Chapter 4

PROJECT RESULTS

Historical Description of the Intervention

The objective of this project was to improve student learning in mathematics and science through the integration of visual art. Various teaching methods were employed and aligned with cross-curricular subjects to effect the desired improvement. Students were introduced to a variety of art mediums and challenged to solve problems in all three subject areas. Students were immersed in information correlated to objectives in the district curriculum guide in the areas of art, mathematics and science.

The variation of teaching methods included discussion and brainstorming, posing problem questions, manipulation of materials, introduction of artists, their work and styles, comparing and contrasting science and art concepts, relating math concepts into artwork and conducting experiments. Students previewed their self-assessment guide before starting their work, which allowed them to target concepts being assessed. Students also used a journal to document ideas, sketch possibilities, note successes and rethink areas that could be improved. Student interest in the project was very high.

The teacher-researcher began by consulting and comparing the district's curriculum in the subject areas of mathematics, science and art. Mathematics concepts that were selected were

taken from state goal 9A and 9B. Goal 9.A.2a states students will build physical models of 2 and 3 dimensional shapes, and 9.A.2b requires that students to be able to identify and describe how geometric figures are used in practical settings. Goal 9.A.2c states students will describe and draw representations of geometric relationships, patterns, symmetries, and designs in two and 3 dimensions without technology, and 9.B.2 states that students will be introduced to and use the vocabulary appropriate for geometric shapes and properties, parallel, perpendicular, similar, congruent, and line symmetry. The science concepts that were selected were from Outcome 7, Standard 1.B. which states concepts related to position and motion of objects and investigating properties of sound (pitch and volume). Also, science state goal 11, which describes unifying concepts and processes, using abilities necessary to do scientific inquiry was incorporated. These goals were tied together with the following art concepts outlined in state goal 25; thinking skills of describing, analyzing, evaluating, defining, explaining, and comparing/contrasting to make judgments, through the use and understanding of the elements and principles of art. State goal 26 states that students will produce artwork, concentrating in the areas of drawing, painting, sculpture and mixed media. State goal 27 was also incorporated which states, as a result of their schooling, students will be able to understand the role of arts in civilizations, past and present.

The teacher-researcher organized, collected and ordered the materials needed. The 4th grade teachers were consulted and informed of the plan and asked to voluntarily participate and provide feedback. The science team at Site A was also consulted for input so the teacher-researcher could have access to science materials that would be needed. The principal at site A was given an overview of what this research plan entailed. The project was outlined and organized to provide a sequence of procedures.

The accumulation of cross curricular concepts pointed to a project of three dimensional form, introducing different types of balance and shape concepts outlined in the math curriculum. For science this project would take the procedures on conducting science experiments, the scientific views of Isaac Newton and his spectrum of color, and the concepts of sound, pitch, volume and vibration. These concepts were intermingled with art concepts of two-dimensional and three-dimensional shapes, as well as color theory, shape, sculpture, multimedia, design and the introduction of Monet's and Picasso's styles.

On the first day of school, each student from the selected class was informed of the project and took home a permission slip to participate. Only 18 students returned their permission slips. To increase the size of the students being monitored, a second 4th grade class was also added. These students were informed of the project and took home permission slips. Twelve permission slips were received from the second group. The second week of school these students previewed their self-assessment, created a portfolio and discussed journaling options. Students took a pretest to create a baseline of their current knowledge. And the project began.

Students have art once a week for a forty-five minute period. No additional time was added to accommodate the research, thus no extra time was taken from the regular classroom studies for this intervention.

Evidence from the results of the pretest showed that students were at the non-mastery level across all three-subject areas. Some students did not write any more than their name and the date. The students that did respond showed difficulty in expressing their thought in their answers. This meant that the researcher needed to model drawing and note taking skills for the journaling to be worth doing. Instead of students being able to freely express an opinion or feeling toward their work as previously set up by the researcher, a more basic approach was

used. Because students were unable to write from a previous set of stem questions the teacher-researcher modeled drawing and basic note taking. As weeks passed the documentation of thoughts improved.

Instead of direct teaching the "how to" method, students visually dissected and compared the shape and form of pictures of musical instruments. They were not restricted to realism. The social aspect also added to the creativity. As one student added something no one else thought of, others were encouraged to try something new. Students were challenged with found items that were usually thrown away, to build their armature. This allowed for thinking and rethinking and making changes and additions without the stress of being wasteful or making mistakes. Students took a flat piece of oak tag (2 dimensional) and drew a shape for the body of their instrument. They traced that shape and made a hole where the sound box would later be inserted and using cardboard rolls and newspaper and masking tape changed the two-dimensional shape into a three-dimensional form by adding depth. They found additions of cardboard, boxes, plastic rings and container tops, sponges and other disposable objects and added these to create interest as well as necessary parts of their musical instrument.

As students finished creating their armature, they were asked to self assess their progress. Many wanted to know the teacher-researcher's opinion. The teacher-researcher discussed the criteria and answered questions then asked the students to make their best judgment.

Students began the next step of their sculpture. Students used paper towel strips and paper mache paste to cover their armature. Neatness and good workmanship were assessed in their self-evaluation.

Early in the intervention, the researcher felt a time crunch. The period was ending before students could put down their thoughts in their journals. Some students liked to write and draw

and others conveniently "forgot" to add to their journal. Absences also allowed some students to fall behind in journaling. The researcher reviewed the journaling, writing and drawing of notes as necessary through the first six weeks. Most students never did write in full sentences, but documented fragmented thoughts and started drawing their ideas. Still other students had a hard time settling down to compose their thoughts for journaling.

The researcher noticed a unified social climate. Students were interactive yet on task with no behavior problems. One week one of the boys put paper mache paste in his hair. The other students were not impressed and let him know that was not the right thing to do. During the self assessment that student noted his lack of responsibility in his actions.

Picasso's cubism was observed. Words describing those shapes were listed along with mathematics terminology, as well as art vocabulary. How students could use Picasso's dissection of parts to create a pleasing design expressing radial, symmetrical or asymmetrical balance was the next problem. Geometric, natural and freeform shapes were discussed in groups who sorted and organized precut shapes to illustrate the type of balance and the concepts of congruent and concentric as well as perpendicular and parallel. All students were given the sheets of paper they needed to cut out the shapes as described in the art and mathematics vocabulary listed on the board. Multiples of a shape which are also the same size or congruent, were created by folding and layering and cutting the papers. In small groups students, discussed, organized and shared ideas, using the terms and concepts listed on the board to influence their design. Students added their cut paper shapes to design their musical instruments. Their designs were self-assessed.

Students then studied the color theory comparison of art and science concepts. The science experiments were a great success. Students stayed in groups and moved around the classroom

from station to station reading instructions, hypothesizing, experimenting and coming to conclusions. They had to make color spinners, mix paint, create a rainbow with light and water and discover the effect of light on color as well as its absence. At the end of class, the teacher-researcher had the students write on the board what they knew about color in art and in science. The different grouping of primary colors in art as opposed to the primaries in science was discovered. Many other discoveries were also discussed.

Students next looked at the impressionist style of Monet. Colors mixed, partially mixed, and colors side by side were pointed out. His color choices were also discussed. Students chose color combinations and began mixing colors and painting their musical instruments. When their instrument was painted they again self assessed their work.

The science concepts of sound, pitch, volume and vibration were the next section of the project. Cards were passed out to each group with the concept words on them. They discussed them and came up with definitions and examples. The teacher-researcher wrote each word on the board and one recorder from each group wrote what they came up with on the board. All the definitions were read, reviewed, discussed and conclusions on meaning were formed. Metal cans, rubber bands, and tape were distributed. Students needed to create four sounds ranging in pitch from low to high. Techniques for stretching the rubber bands and securing them with tape were shared among students. As students began to "check" their sounds they got quite excited. They were surprised to find out they could make a variety of pitches with just cans and rubber bands. They worked together adjusting to accurately achieve their four sounds ranging high to low in pitch. Concept words were documented in their journals.

The next week they put the sound boxes in their instrument, and varnished over their painted musical instrument and self assessed their sound box. The following week, music sheets were

passed out and students connected the high and low pitched strings with musical notes in simple songs. Students practiced the songs and made up some of their own songs. Then the second half of the period, the researcher taped their music. They documented their achievement in their journals and self assessed their work while waiting to perform. Students then took the posttest to assess increased knowledge of the concepts presented throughout the intervention. The musical instruments were on display for two weeks. Students were anxious to take them home.

Presentation and Analysis of Results

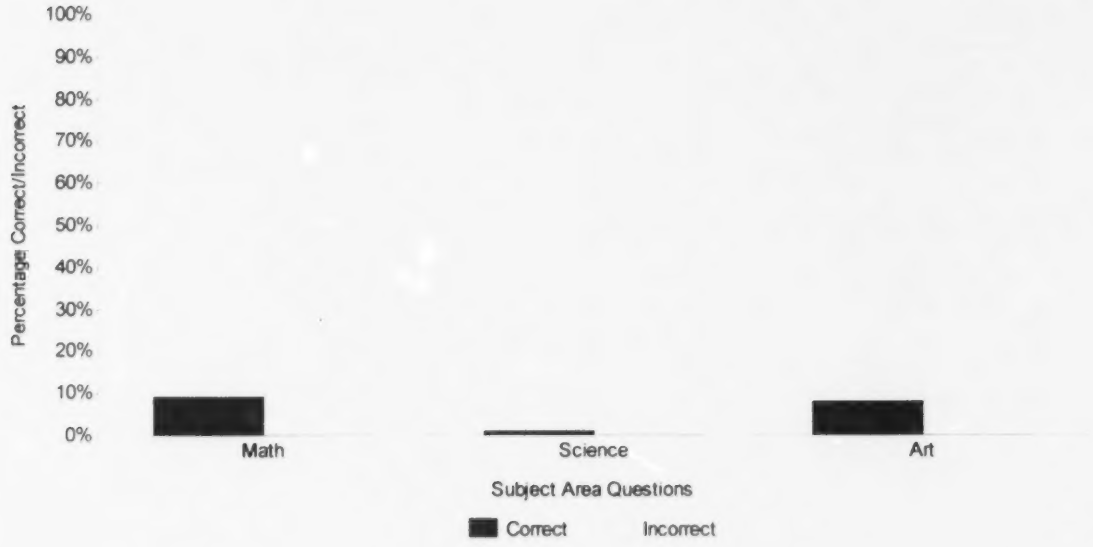

Figure 5. Pretest results.

The intervention, according to the comparison of the pretest and posttest, had a positive effect on learning in all three subject areas of art, mathematics and science. Looking at the data collected the teacher-researcher gained insight on students' weaknesses, strengths, struggles and victories in learning.

Figure 5 shows the beginning knowledge levels taken from the pretest. Students ranked at non-mastery levels in all three subjects. Less than 10% of the mathematics questions were correctly answered, in science only 1% were correctly answered and in art only 8% were correctly answered.

This pretest also gave the teacher-researcher information about how these students express themselves. The teacher-researcher noticed that students were very reluctant to express thought through pictorial representation. Also, fragmented sentences and thoughts kept the student from revealing all of what they might know. The teacher used journaling including drawings as well as writing as practice for documenting ideas, and communication to the teacher as to their thought processes. This helped to organize student thought and communicated to the teacher-researcher details that students did not describe in words.

Also a self-assessment grid was given to students (Appendix B). This tool helped sharpen their critical thinking skills, and helped students focus on targeted areas by pre-reading what skills and concepts would be assessed, before the students actually started on their task. This gave students a broader view of what was expected in their work.

Even though the pretest results were very low, it provided valuable information and directed the intervention to include practice of written communication skills. The researcher used the cross curricular intervention, with varying teaching methods and checked journaling and portfolio planning. These interventions, combined with encouraging critiquing and assessing of their work by the students themselves proved to gain learning in all targeted subject areas. The following tables show student input in assessment and journaling.

Table 2. Student self assessment portfolio.

Projects/Assignments	Assessment Codes				
	1	2	3	4	5
Armature	23%	40%	27%	10%	0
Paper mache	40%	30%	20%	6%	0
Design	17%	40%	26%	17%	0
Painting	40%	26%	27%	6%	0
Sound Box	34%	40%	13%	13%	0
Whole Musical Instrument	17%	66%	17%	0	0

1-Excellent 2-Highly Satisfactory 3-Satisfactory

4-Experiencing Difficulty 5-Experiencing Great Difficulty

Table 2 shows how students viewed and rated their own work. Students looked at the Portfolio assessment before being introduced to the concepts. The first few times the teacher-researcher went through each and explained in more detail exactly what each of the labels meant and how to know which were targeted for the next project. The first week the students wrote in the word armature and the teacher researcher explained that "unique idea" referred to original ideals relating to the shape and form and how their armature was put together. "Creativity" would be rated as to how students used their own ideas and related them to the musical instruments in the prints and showed their view of how a musical instrument could be represented. These two areas represent the interpretation section of critique. Next Good workmanship meant how well the armature was put together, both neatly and securely. Followed guidelines and work finished was also part of the technique critique. The last section, "shows understanding of concepts" means by looking at the finished armature, does it show

your knowledge of 2 dimensional verses 3 dimensional concepts. Also, in the critical process is how well you worked with the people around you. The areas not being assessed were colored in with pencil to note that area did not apply to this section of the project. Students went to work on their assignment, then critiqued themselves on how well they thought they did. This continued for paper macheing their form, adding their design, painting, adding their sound box, and finally the assessing of their whole instrument. The students did a nice job assessing their work.

Table 3. Student journal documentation of concepts learned.

Concepts Documented	**Weeks**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Well	**0**	**6%**	**14%**	**30%**	**10%**	**40%**	**30%**	**40%**	**40%**	**34%**	**34%**	**50%**
Somewhat	**14%**	**17%**	**16%**	**16%**	**20%**	**23%**	**20%**	**26%**	**40%**	**26%**	**23%**	**34%**
Not Communicated	**86%**	**77%**	**70%**	**54%**	**70%**	**37%**	**50%**	**34%**	**20%**	**40%**	**43%**	**16%**

Table 3 shows the progression of student journaling. At the beginning of the intervention, this group of students wrote very little. The teacher-researcher initially, then periodically modeled the writing and drawing process. Full sentence structure, correct spelling and punctuation were not emphasized. Diagrams, pictures, sketches, comparisons, labeling, "I think" word bubbles were encouraged. Students made a good improvement, but this teacher researcher believes this is a beginning model to carry on, build on and encourage these students in the next two years. The thinking about the concepts during journaling, helped students retain

information from week to week shown through review and connecting concept discussions. Some students liked the activities and could relate the information verbally yet had difficulty documenting their knowledge in their journal.

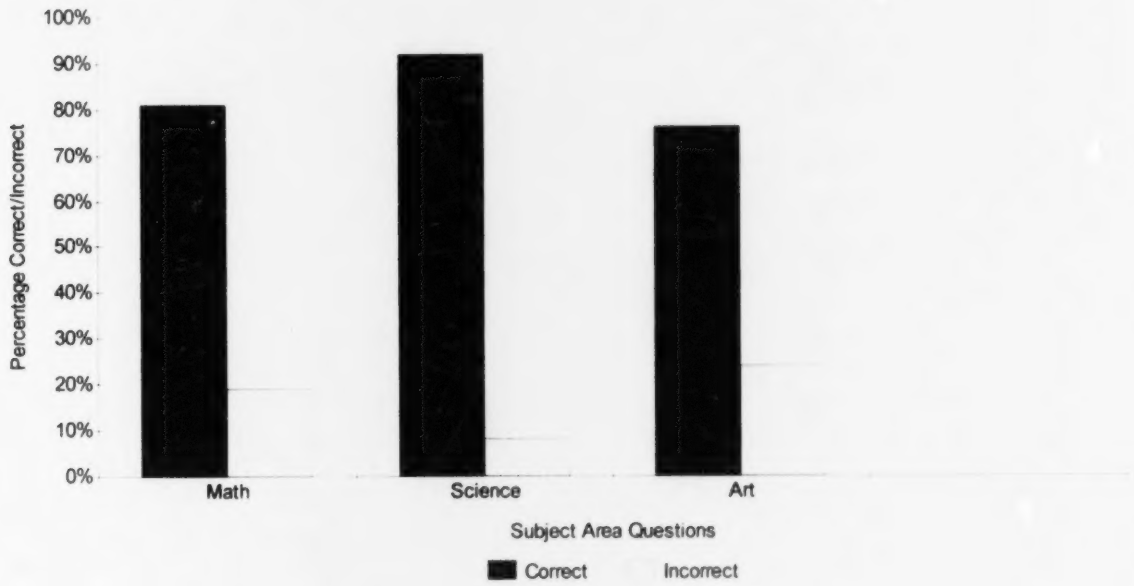

Figure 6. Posttest results.

The intervention of various teaching methods allowed for all students at some time to use the strategy that definitely worked for them, and introduce them to other teaching methods. This variety of teaching methods made the information more interesting to both the students and the teacher-researcher. Figure 6 shows the positive result of using these interventions. Students answered 81% of the math questions correctly compared to 19 answered incorrectly. Students answered 91% of the science correctly missing only 9%. In art the number of correctly answered was 76% with 24% answered incorrectly.

The social aspect of discovering and sharing information and trying out new ideas without any worry of failure encouraged students to think outside the box. Students, who may not have liked one or more of the subjects initially, took inspiration from integrating their interests from another subject. The teacher-researcher noticed students in leadership roles, who before the intervention, stayed in the background and only did just what was minimally expected. Students learned connections in the subjects of art, mathematics and science. These series of lessons could easily have incorporated music, recycling, and writing into the criteria.

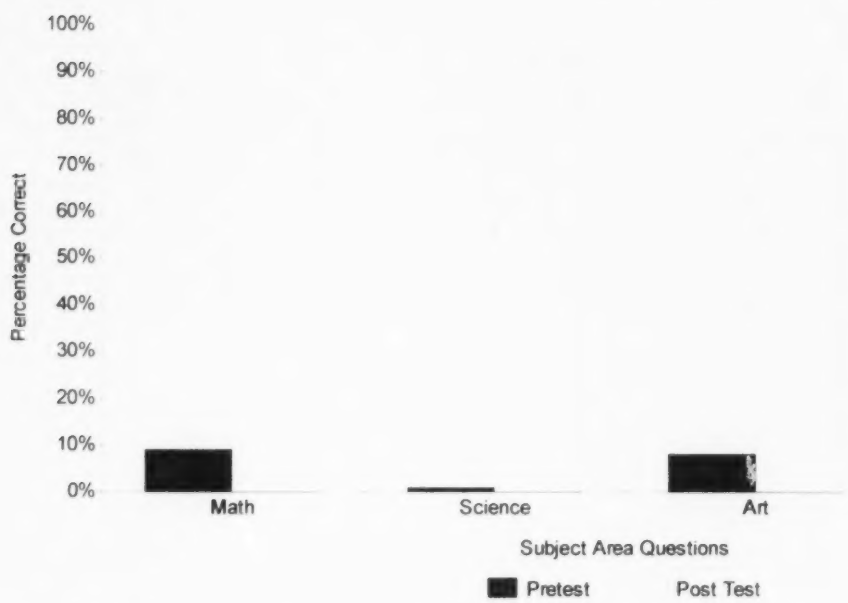

Figure 7. Comparison of pretest and posttest assessments.

In figure 7 a comparison of pretest and posttest results shows increased student knowledge in the three subject areas of art, mathematics and science. The comparison of the pretests and posttests indicate a substantial increase in student learning in each subject area. This graph compares the score of the pre-and posttests. The results show a mathematics pretest score of 9% compared to the posttest score of 81% equaling an increase of 72 points. In science, the

pretest score was 1% compared the posttest score of 92% generating an increase of 90 points. In art the pretest score was 8% compared to the posttest score of 76% equaling an increase of 68 points.

Table 4 charts the mean, median, mode and range of the 15 point pretest and posttest. The improvement made by the targeted group is shown in the following data. The pretest mean or the average grade was one compared to the posttest mean of 11.5, creating a 10.5 difference. The pretest median or middle number in the list of scores was 0 and the posttest median was 13, making a 13 point difference. The mode or the score that appears most frequently in the pretests was zero and in the posttests was 13, also creating a 13 point difference. The range of answers correct increased. The range of the pretest was five with the range of the posttest being 11. A measurable difference was made in all recorded data areas.

Table 4. Comparison of mean, median, mode and range in pretests and posttests.

	Pretest	Posttest
Mean	**1**	**11.5**
Median	**0**	**13**
Mode	**0**	**13**
Range	**5**	**11**

The cost of the intervention was not expensive. The researcher bought oaktag, masking tape, paper mache paste, tempra paint, varnish, paper for journaling, and construction paper for portfolios and designs and glue. These are all items usually purchased by this art teacher. The teacher-researcher also collected newspaper, cans, and miscellaneous disposable forms with the

help of students and their parents. The school provided rubber bands and paper toweling. The teacher-researcher already had in the supply inventory art prints, a tape recorder, and was able to borrow items from the science department necessary for experiments. The actual cost of implementation was approximately $50.00 for the 16 week intervention. The effect size versus the cost of the project shows that this intervention was worth doing and continuing to do.

Conclusions and Recommendations

Based on the presentation and analysis of the data relating the integration of visual art into the core curriculum subjects of mathematics and science, the target group of students showed a substantial gain in knowledge. Students maintained portfolios and journals and self assessed their work. Journaling practice originally was employed as an alternative assessment technique, but it also affected the posttest results in ability to communicate knowledge learned. Students experienced a variety of teaching methods, exposing them to new methods each week. Through the comparison of the pretests and posttests, students in the target group increased their knowledge in all three subject areas. In conclusion the alignment of these curricula, with the use of various teaching strategies and the use of alternate assessment methods increased student learning in the core subjects of mathematics and science through the integration of visual art.

The recommendations given to other teachers and researchers include looking into timing issues and the importance of including the journaling intervention. The targeted mathematics and science concepts are taught throughout the year in correlation with the units in the texts. This project introduced concepts that were later confirmed in the classroom. This visual art integration project was completed in 16 weeks, where as the targeted concepts were taken from

classroom units throughout the whole school year. Some of the science and mathematics concepts were not covered in the classroom until after the intervention was finished. Even though this project was highly successful, the researcher feels that even a greater success could have been gained if the timing factor were completely aligned.

The positive outcome of this intervention encourages this teacher-researcher to align curriculums at other grade levels and create projects covering mathematics and science as well as other core curriculum areas. The use of different teaching strategies definitely made the teaching/learning process more interesting. The use of a rubric self assessment kept students knowledgeable on what is expected of them. This teacher-researcher also believes that continued journaling and drawing of concepts and ideas was a strong influence on the retention of information. This area had to be modeled and reviewed throughout the intervention, but was worth the time. This intervention was fast paced, kept students' interest, and produced wonderful pieces of work exhibiting their accomplishments. It was enjoyable for both the teacher-researcher and the students.

To conclude this study this teacher-researcher strongly agrees with Stephen Stapleton, Chairman for Partnership for Arts, Culture and Education, "Art experiences can no longer be perceived as pleasant fluff compared to more substantive areas of instruction: math, science, reading, and writing. When used in an integrated manner, with teachers trained in the techniques of incorporating arts programming into the core curriculum, art becomes a vital tool in increasing a child's understanding and academic achievement" (Stapelton, 1998, p.6). The results of other studies along with this intervention prove the integration of visual art into the areas of mathematics and science was a solution to improve student learning.

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Appendices

Appendix A

Consent to Participate in a Research Study

Pretest for 4th grade Integrated 3-D Musical Instruments

SAINT · XAVIER · UNIVERSITY

CHICAGO

Consent to Participate in a Research Study
Improving Learning in Math and Science Through the Integration of Visual Art

Dear Parent or Guardian,

I am currently enrolled in a master's degree program at Saint Xavier University. This program requires me to design and implement a project on an issue that directly affects my instruction. I have chosen to examine the affects of integrating visual art into math and science.

The purpose of this project is to align the art curriculum with the district goals in math and science. It will help your student see a connection among the subjects and help retain some basic concepts. I will be conducting my project from the first week in September to the first week in December of this school year. The activities related to the project will take place during regular instructional delivery. The gathering of information for my project during these activities offers no risks of any kind to your child.

Your permission allows me to include your student in the reporting of information for my project. All information gathered will be kept completely confidential, and information included in the project report will be grouped so that no individual can be identified. The report will be used to share what I have learned as a result of this project with other professionals in the field of education.

Participation in this study is completely voluntary. You may choose to withdraw from the study at any time. If you choose not to participate, information gathered about your student will not be included in the report.

If you have any questions or would like further information about my project, please contact me at Lords Park Elementary School, (847) 888-5360.

If you agree to have your student participate in the project, please sign the attached statement and return it to me. I will be happy to provide you with a copy of the statement if you wish.

Sincerely,

Mrs. Joyce Hanson

Mrs. Joyce Hanson - Art Teacher

PLEASE RETURN THE ATTACHED STATEMENT TO ME BY August 31,2001.

Consent to Participate in a Research Study

Improving Learning Standards in Math and Science Through

the Integration of Visual art

I, _____, the parent/legal guardian of the minor named below, acknowledge that the researcher has explained to me the purpose of this research, identified any risks involved, and offered to answer any questions I may have about the nature of my child's participation. I freely and voluntarily consent to my child's participation in this project. I understand all information gathered during this project will be completely confidential. I also understand that I may keep a copy of this consent form for my own information.

NAME OF MINOR:_____

Signature of Parent/Legal Guardian
(Date):_____

Pretest/Post test for 4th grade Integrated 3-D Musical Instruments

Name_____ Date_____

What can you tell me about Isaac Newton?

What can you tell me about Pablo Picasso?

Tell me what you know about color as it relates to art and science.

Explain 2 dimensional. Explain 3 dimensional.

Draw a design that is symmetrical. Draw a design that is asymmetrical.

Explain pitch and volume.

Appendix B

Art Assessment Portfolio

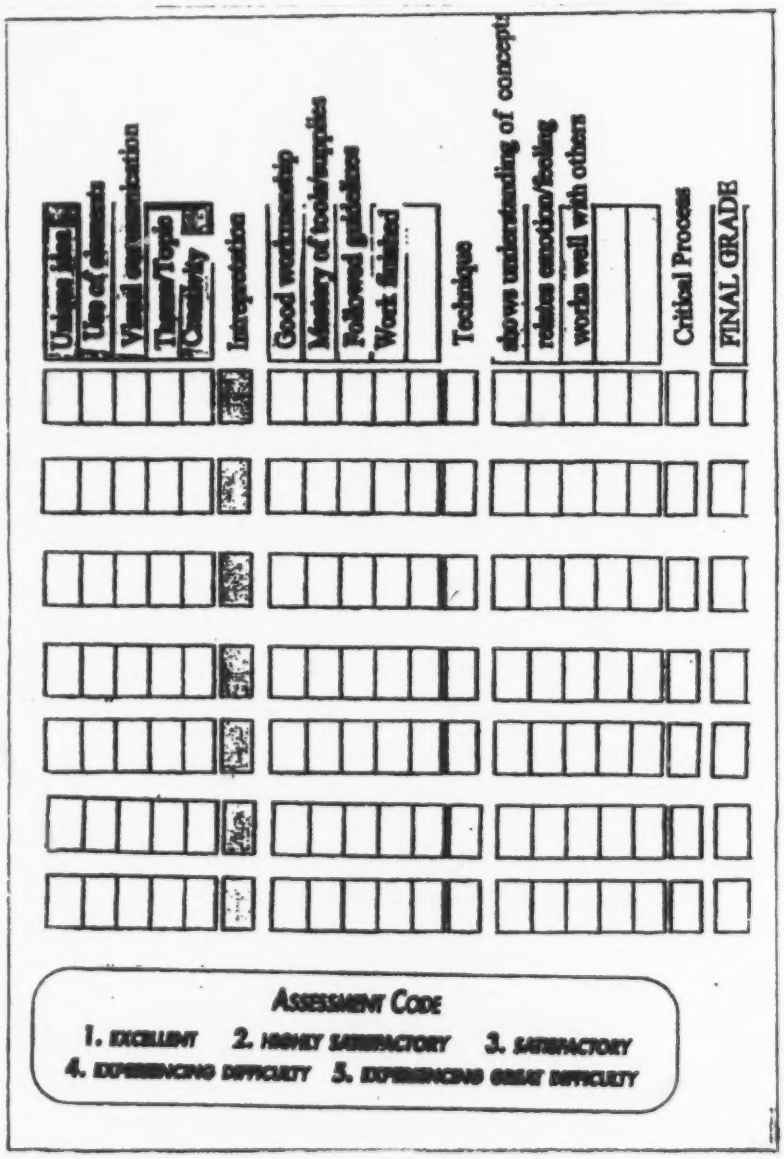
Art Chart Journal

Posttest for 4th grade Integrated 3-D Musical Instruments

Art Assessment Portfolio

Student Name_____

Art Teacher_____



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ART CHART JOURNAL

Name_____

What I know/What I want to know

What I learned

Pretest/Post test for 4th grade Integrated 3-D Musical Instruments

Name_____ Date_____

What can you tell me about Isaac Newton?

What can you tell me about Pablo Picasso?

Tell me what you know about color as it relates to art and science.

Explain 2 dimensional. Explain 3 dimensional.

Draw a design that is symmetrical. Draw a design that is asymmetrical.

Explain pitch and volume.

Appendix C

Lesson Plans for 3 Dimensional Musical Instrument

Armature

Paper Mache

Design and Balance

Color Experiments

Painting and Color Mixing

Creating a Sound Box

LESSON PLAN

For: Armature
Class Periods: 2

Subjects Integrated and Goals Targeted

Art - #26
Mathematics - #9A,2a
Science

Materials

Prints of stringed instruments, masking tape, oaktag 9"x12", pencils and erasers, scissors found items such as small boxes, cardboard rolls, plastic rings, foam, newspaper and any other found objects students wanted to add

Terms and Concepts

2-dimensional	3-dimensional	
armature	shape	form

Procedures

Present prints – look at types (violins, guitars, ect.), parts, (body, arm, strings), dissect parts into shapes and forms
Discuss - realism verses artist interpretation and possibilities
- 2-dimensional and 3-dimensional concepts
- require all instruments have a body and an arm

Students draw a shape (2-D) on oaktag for the body (top also needs a hole for the sound box) then trace and cut a second for the bottom (no hole) and turn it into a form (3-D). They make additions of found items by manipulating, cutting folding bending and securing with masking tape. The body is enclosed with folded strips of newspaper to create a solid form.

Assessment

Student self assessment on: unique idea, creativity, good workmanship, followed guidelines, shows understanding of concepts, and works well with others.
Journal on concepts

LESSON PLAN

For: Paper Mache
Class Periods: 2

Subjects Integrated and Goals Targeted

Art - #25, #26
Mathematics - #9A,2a
Science

Materials

Paper Mache paste, bowls, strips of paper towel, newspapers to cover the work areas, drying areas covered with cut garbage bags so armature does not stick

Terms and Concepts

form
paper mache
technique
good workmanship

Procedures

Demonstrate how to dip strips into the paste and take off extra paste, smooth strips over armature to create a smooth surface. Completely cover top, bottom and sides.

Assessment

Student self assessment on good workmanship, mastery of supplies/techniques, followed guidelines, finished work, works well with others.
Journal on concepts

LESSON PLAN

For: Design
Class Periods: 3

Subjects Integrated and Goals

Art #25, #26, #27
Mathematics #9A.2c, #9B.2
Science

Materials

masking tape
prints of Picasso's cubist style
teacher precut foam shapes for presentation and student manipulation
scissors
paper
glue

Terms and Concepts

BALANCE	SHAPE	congruent	Pablo Picasso
radial	natural	concentric	cubism
asymmetrical	freeform	perpendicular	overlapping
symmetrical	geometric	parallel	collage

Procedures

Show two prints of Picasso's The Musicians and Three Musicians. Have groups of students compare. Find information: how many people in each? Draw one of the people in Picasso's style. What are the instruments? Draw them in the same style as Picasso. Describe and list the colors, patterns, and shapes. Do you like this style? Which painting do you like best ? Why? How does it make you feel when you look at the people? What mood are they in? Hunt for extras, detail anything else your group wants to add. Have each group share discoveries, adding the terms and concepts of Pablo Picasso, cubism, overlapping and collage to the discussion.

Have precut shapes of foam in packets for each table. Have students work together in groups of four to sort into natural freeform and geometric. Discuss. Have groups create congruent, concentric, perpendicular and parallel combinations. Discuss. Have 6 chalk outlines of musical instruments on the board. Two labeled radial, two labeled symmetrical and be labeled asymmetrical. Assign groups to organize and create a design that corresponds to their assigned concept with the foam pieces and tape to the chalk board. Have the class discuss and compare the designs.

Students will cut shapes (geometric, natural, and freeform) from paper and glue onto (collage) their musical instrument, creating one of the types of balance. They will also incorporate concentric, congruent (folding and cutting multiples of the same shape and size), parallel and perpendicular in their organization of shapes creating an interesting design.

Assessment

Student self assessment on unique idea, use of elements, visual communication, theme topic, creativity, good workmanship, mastery of tools/supplies, followed guidelines, work finished, shows understanding of concepts, related emotion or feeling, works well with others.
Journal on concepts

LESSON PLAN

For: Color experiments
Class Periods: 1

Subjects Integrated and Goals

Art #25
Mathematics
Science #11

Terms/Concepts, Materials and Procedures

Stations set up around the classroom. Each station has hypothesis/conclusion sheets, and instructions for that station.

Station 1
Color mixing compliments
tempra paint, brushes, palette
Hypothesize what color will be made for each of the Following formulas:
If we mix:
Red + Green =_____
Purple + Yellow =_____
Orange + Blue =_____
Was your hypothesis Correct?
Mix all the colors.
All colors in pigment (paint)
Make what color?

Station 2
Making a rainbow
Information on Isaac Newton and his prism to split light into color. Prisms, crystals, pan of water, mirror, cardboard station needs to be by window, flashlight in case of no direct sunlight.
Hypothesize what will happen with the light mirror and water?
Place mirror in the water at an Angle. The edge of water acts as a prism and splits up the light so you can see different colors – count and record the colors. Put the magnifying glass between the mirror and the cardboard
What happens? The lens bends the light so the colors go back together. All colors in light make what color?

Station 3
Color wheel
color wheels
large paper with shapes for color
tempra paint ONLY primary colors
Paint each of the Primary colors in the circles.
What will happen when each two are mixed. Look at the color wheel to know where to place them. The go between the two colors that made them
They are secondary colors.
Students continue with intermediate colors. What are the primary colors of paint (pigment)?

Station 4 -Color spinner
Construction papers of all 7 colors of the spectrum and white, scissors glue. Trace circle 4" in diameter – divide into 7 equal parts with protractor (51 degrees wide) cut out one section and trace the seven colors of the spectrum glue each into a circle. Hypothesize

what will happen when spun? Place a piece of tape on the back and place on turntable and spin. Document what you see. Next make another spinner only with red blue and green. These are primary colors of light. Hypothesize what will happen when spun. Document conclusions.

Station 5
Color and light/absence of light
Most objects do not produce light of their own. They reflect light that falls on them and our eyes see the reflected light. They make their hypothesis then on their T chart each group documents the color of 6 items seen out of the box and then placing the items in the box and documenting the color looking through a hole in a box lined in black. Document conclusions.

Tints and shades
Choose one color, scoop one spoonful on to the middle of the palette. Paint one rectangle at tem top of the paper with that color add one teaspoon of white mix and paint next rectangle, continue 12 times. Hypothesize what will happen. On you second paper repeat only using black. Hypothesize what will happen. Document conclusions. Compare how many rectangles it took to turn the color white verses how many times it took to turn black.

Students document their conclusions on the board. Compare and contrast color in art and science.

Assessment

Journal on concepts.

LESSON PLAN

For: Painting and color mixing
Class Periods: 3

Subjects Integrated and Goals

Art #25, #26, #27
Mathematics
Science

Materials

prints of haystacks, the Japanese Bridge, and flowers painted by Claude Monet
tempra paints
palettes
paintbrushes (various sizes)

Terms and Concepts

light and color at different times of the day
color combinations –complimentary, analogous, tints, shades, primaries, secondaries, warm and cool colors
repetition repeated to show unity, balance, to enhance interest
Impressionism
Claude Monet
color mixing,
color blocking
laying down color side by side in small brush strokes to let your eyes mix the colors
painting techniques/use of brushes/water

Procedures

Look at the prints by Claude Monet. Have students stand by the one the like the best. How do the colors make you feel? Discuss warm and cool colors, tints and shades. Discuss how color can relate or communicate feelings. The haystacks and water lilies were painted at different times of day and different seasons. As you can see the light and color changed in every painting. Look at one area and count how many colors Monet used he placed small patches of color side by side and as you move back your eyes blend the colors. The flowers are more of a blocked technique. The same color was used in larger areas. Look for colors that are mixed. You can see some of each color as well as the blended areas.

Pass out color wheels to every student. Discuss complimentary colors show how to find compliments on the color wheel. Discuss analogous colors, find on color wheel. Discuss tints, shades, primary and secondary color combinations and the techniques used – mixing, color blocking and laying down colors side by side in small patches to allow your eyes to mix them visually. Discuss the use of brushes and size and types for various techniques.

Students choose their color combinations and use various techniques to paint their musical instrument.

Assessment

Student self assessment on unique idea, use of elements, visual communication, theme, creativity, good workmanship, mastery of supplies, followed guidelines, finished work, shows understanding of concepts, relates emotion or feeling, works well with others. Journal on concepts.

LESSON PLAN

For: Sound Boxes and playing instrument
Class Periods: 2

Subjects Integrated and Goals

Art
Mathematics
Science #1.B.

Materials

Notecards with sound, pitch, vibration and volume written on each
tin cans
rubber bands
masking tape
witten music for simple songs

Terms and Concepts

sound
pitch
vibration
volume

Procedures

Students are in groups of 4. Each group has a set of note cards with the 4 vocabulary words on them. The teacher begins discussion by asking students to place their hands on their neck where their voice box is. Students are asked to talk, then sing a short song, and hum. Then the teacher says that is vibration, on the note card with the word vibration explain what it means. Students discuss the concept and write or draw the definition. The teacher then uses a radio and turns the volume low higher, higher and loud. That is volume, on you note card with the word volume, write what it means. Group works again on definition. The teacher then uses a small keyboard and plays four notes from low to high and says this is pitch, write it's definition on the card that says pitch. The groups go back to work. All of these concepts have to do with sound. Sounds are produced by vibrating objects and vibrating columns of air. Pitch and volume are two characteristics of sound. Discuss students definitions.

Changing the way an object vibrates can change the pitch and volume of the sound produced.

*Pitch is determined by the frequency of the vibrations.

*Volume is determined by the amplitude of the vibrations. (Plucking hard soft - demonstrate on a rubberband)

*Changing the length, tension, or thickness of a string affects the frequency of the vibration and therefore pitch is produced. Place a rubber band around a can stretching very little pluck and see the movement LOW SOUND - stretch tightly the rubber band and pluck it – tightened its movement is limited – HIGH SOUND)

Students are given tin cans, rubber bands, and masking tape to create four pitches ranging low to high.

Students find the highest note to lowest notes and relate it to written music. The practice some simple songs. Then they make up ones of their own.

Assessment

Student self assessment on Good workmanship, mastery of tools/supplies, followed guidelines, work finished. Shows understanding of concepts, works well with others Journal on concepts.